

THE UNIVERSITY OF AUCKLAND

SUMMER SCHOOL 2020

Campus: City

COMPUTER SCIENCE

Introduction to Computer Systems

(Time Allowed: TWO hours)

Note:

- Your Teleform sheet is stapled at the end of this question/answer book. Remove the Teleform sheet from the question/answer book.
- The version code for this question/answer book is **00003784**. You MUST carefully check that this version code corresponds to the one on the Teleform. If the version codes do not match, please inform the exam supervisor IMMEDIATELY.
- Enter your name and student ID on the Teleform sheet. You must also enter your name and student ID on this question/answer book in the space provided below.
- Enter your answers on the Teleform. Answers entered in the question/answer book will not be marked.
- At the end of the exam, submit the Teleform only. You MUST retain this question/answer book until the marking is complete and you have received the mark or grade for this assessment.
- Each of the 45 questions is expected to have exactly 1 (one) correct answer. If you believe that a question has either NO or MULTIPLE correct answers, select the ONE you believe is most likely to be the intended answer.
- All questions carry equal marks. You must answer 40 out of the 45 questions correctly in order to obtain full marks in this exam. Any excess marks may be used to offset marks lost in the mid-semester test.
- This exam counts for 50% of your final grade.

Name:

ID:



1. Which of the following strings, when compressed with the RLE algorithm discussed in class, will result in a compression ratio of 1.5 or more?
- X. Mississippi
 - Y. NooooOOOO
 - Z. bookkeeper
- A. X only
 - B. Y only**
 - C. Z only
 - D. None of X, Y, and Z
 - E. All, or two of X, Y, and Z
2. Which of the following additions are **CORRECT**? Note the subscripts denote the bases (8=octal, 16=hexadecimal).
- X. $3364_8 + 274_8 = 3660_8$
 - Y. $5204_8 + 325_8 = 5531_8$
 - Z. $5414_8 + 221_8 = 5635_8$
- A. X and Y only
 - B. X and Z only
 - C. Y and Z only
 - D. All of X, Y, and Z**
 - E. None, or only one of X, Y, and Z
3. Which of the following subtractions are **CORRECT**? Note the subscripts denote the bases (8=octal, 16=hexadecimal).
- X. $7366_8 - 65_8 = 7300_8$
 - Y. $6051_8 - 356_8 = 5473_8$
 - Z. $B59_{16} - C1_{16} = A98_{16}$
- A. X and Y only
 - B. X and Z only
 - C. Y and Z only**
 - D. All of X, Y, and Z
 - E. None, or only one of X, Y, and Z

4. Which of the following answers correctly give the 8-bit two's complement of the specified decimal number?

X. 111 is 0110 1111

Y. -23 is 1110 1001

Z. -83 is 1101 0011

A. X and Y only

B. X and Z only

C. Y and Z only

D. All of X, Y, and Z

E. None, or only one of X, Y, and Z

5. Which of the following are correct representations of the specified decimal values in the 16-bit floating point format presented in lectures and the textbook? Note that the floating point representation has been expressed in hexadecimal.

X. -0.5 (decimal) is C000 (hexadecimal).

Y. 0.0625 (decimal) is 4022 (hexadecimal)

Z. -0.375 (decimal) is E001 (hexadecimal).

A. X and Y only

B. X and Z only

C. Y and Z only

D. All of X, Y, and Z

E. None, or only one of X, Y, and Z

6. Given that the hexadecimal value of the ASCII code for "A" is 41, the ASCII code for "a" is 61 and the ASCII code for "1"(one) is 31, which of the following statements are TRUE? All numbers are in hexadecimal.

- X. The ASCII code for "z" is 86.
 - Y. The first 32 ASCII codes are for control characters.
 - Z. The decimal value of numeric characters can be obtained by looking at the 4 most significant bits of their hexadecimal ASCII codes.
- A. X only
 - B. Y only**
 - C. Z only
 - D. None of X, Y, and Z
 - E. All, or two of X, Y, and Z

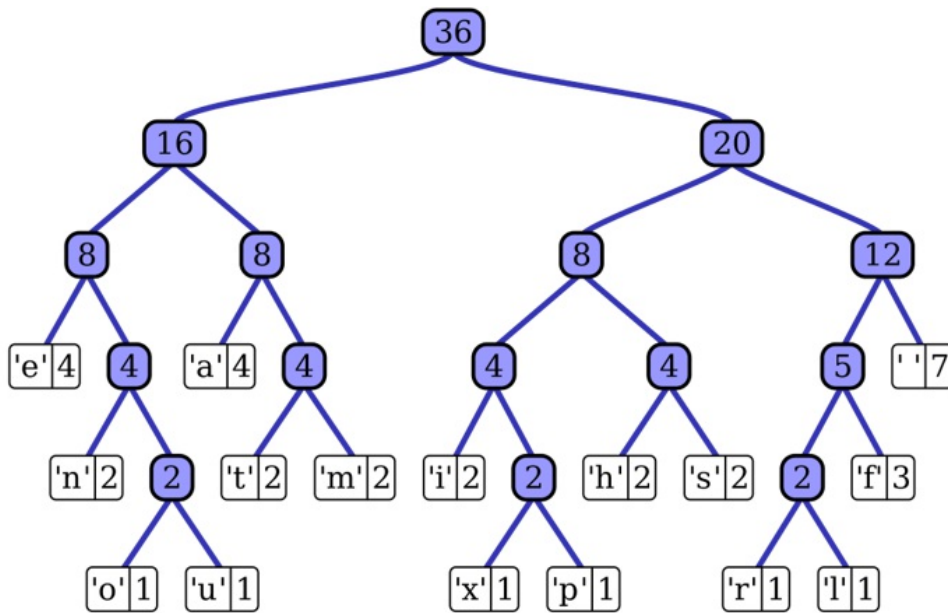
7. Consider the truth table below:

| A | B | C | Output |
|---|---|---|--------|
| 0 | 0 | 0 | 1 |
| 0 | 0 | 1 | 0 |
| 0 | 1 | 0 | 0 |
| 0 | 1 | 1 | 0 |
| 1 | 0 | 0 | 0 |
| 1 | 0 | 1 | 0 |
| 1 | 1 | 0 | 1 |
| 1 | 1 | 1 | 0 |

Which of the following boolean expressions match the output column in the truth table above?

- X. $(\text{NOT } A \text{ AND } B \text{ AND } C) \text{ OR } (A \text{ AND NOT } B \text{ AND NOT } C)$
 - Y. $(\text{NOT } A \text{ AND NOT } B \text{ AND } C) \text{ OR } (\text{NOT } A \text{ AND } B \text{ AND NOT } C)$
 - Z. $(\text{NOT } A \text{ AND NOT } B \text{ AND NOT } C) \text{ OR NOT } (\text{NOT } A \text{ OR NOT } B \text{ OR } C)$
- A. X only
 - B. Y only
 - C. Z only**
 - D. None of X, Y, and Z
 - E. All, or two of X, Y, and Z

8. Consider the Huffman tree below:



Which of the following statements about this Huffman tree are TRUE?

- X. The Huffman code for 'f' is 1101.
- Y. The Huffman code for 'p' is 01100.
- Z. The Huffman code for space (' ') is 111.

- A. X and Y only
- B. X and Z only**
- C. Y and Z only
- D. All of X, Y, and Z
- E. None, or only one of X, Y, and Z

9. Which of the following statements are **TRUE**?

- X. The Von Neumann cycle consists of the fetch, store and execute phases.
- Y. The principle of locality states that values close to recently accessed memory are less likely to be accessed.
- Z. The program counter register holds the address of the next instruction.

- A. X and Y only
- B. X and Z only
- C. Y and Z only
- D. All of X, Y, and Z
- E. None, or only one of X, Y, and Z**

10. Here is a program using the pseudocode presented in lectures:

```

get number
first ← 1
second ← 1
value ← 0
if number <= 2 then
    value ← 1
else
    count ← 3
    while count <= number
        value ← first + first + second
        first ← second
        second ← value
        count ← count + 1
    end while
end if
print value ↵

```

Using this program, which of the following give the correct output with the given input?

- X. Input: 8, Output: 85
- Y. Input: 3, Output: 4
- Z. Input: 5, Output: 13

A. X only

B. Y only

C. Z only

D. None of X, Y, and Z

E. All, or two of X, Y, and Z

11. Here is an assembly language program using the textbook language (the appendix contains the textbook instruction set):

```

        .BEGIN
        IN X
L:      LOAD X
        COMPARE Z
        JUMPEQ E
        LOAD W
        ADD Y
        STORE W
        INCREMENT Y
        DECREMENT X
        JUMP L
E:      OUT W
        HALT
W:      .DATA 0
X:      .DATA 0
Y:      .DATA 1
Z:      .DATA 0
        .END

```

Using this program which of the following give the correct output with the given input?

- X. Input: 3, Output: 6
- Y. Input: 5, Output: 15
- Z. Input: 1, Output: 1

- A. X and Y only
- B. X and Z only
- C. Y and Z only
- D. All of X, Y, and Z**
- E. None, or only one of X, Y, and Z

12. Here is an assembly language program using the textbook language. The comments at the right end of each line are for numbering the lines. The program starts at address zero. The appendix contains the textbook instruction set.

```

        .BEGIN          -- line 1
        IN X            -- line 2
L:      LOAD X          -- line 3
        ADD X           -- line 4
        STORE X         -- line 5
        LOAD Z          -- line 6
        COMPARE Y       -- line 7
        JUMPEQ E        -- line 8
        DECREMENT Z    -- line 9
        JUMP L          -- line 10
E:      OUT X           -- line 11
        HALT            -- line 12
X:      .DATA 0         -- line 13
Y:      .DATA 0         -- line 14
Z:      .DATA 3         -- line 15
        .END            -- line 16

```

Using this program, which of the following have the correct machine code and data (both in hexadecimal) for the specified line?

- X. Line 6 - 000D
- Y. Line 14 - 0000
- Z. Line 4 - 300D

A. X and Y only

- B. X and Z only
- C. Y and Z only
- D. All of X, Y, and Z
- E. None, or only one of X, Y, and Z

13. Consider the following C or Java source code:

```
while (j > r + 1) { j = -f2 / count;}
```

If analysed with the lexicographical analyser from the lectures, how many tokens and token classes do we find here?

- A. 18 tokens and 13 token classes
- B. 16 tokens and 13 token classes
- C. 18 tokens and 14 token classes
- D. 17 tokens and 11 token classes
- E. 17 tokens and 13 token classes

14. Which of the following BNF specifications are recursive?

- X. $\langle \text{sum} \rangle ::= \langle \text{sum} \rangle + \langle \text{term} \rangle \mid \langle \text{term} \rangle$
- Y. $\langle \text{search} \rangle ::= \langle \text{xalphas} \rangle \mid \langle \text{xalphas} \rangle + \langle \text{search} \rangle$
- Z. $\langle \text{digit} \rangle ::= 0 \mid 1 \mid 2 \mid 3 \mid 4 \mid 5 \mid 6 \mid 7 \mid 8 \mid 9$

- A. X and Y only
- B. X and Z only
- C. Y and Z only
- D. All of X, Y, and Z
- E. None, or only one of X, Y, and Z

15. Consider the following BNF grammar:

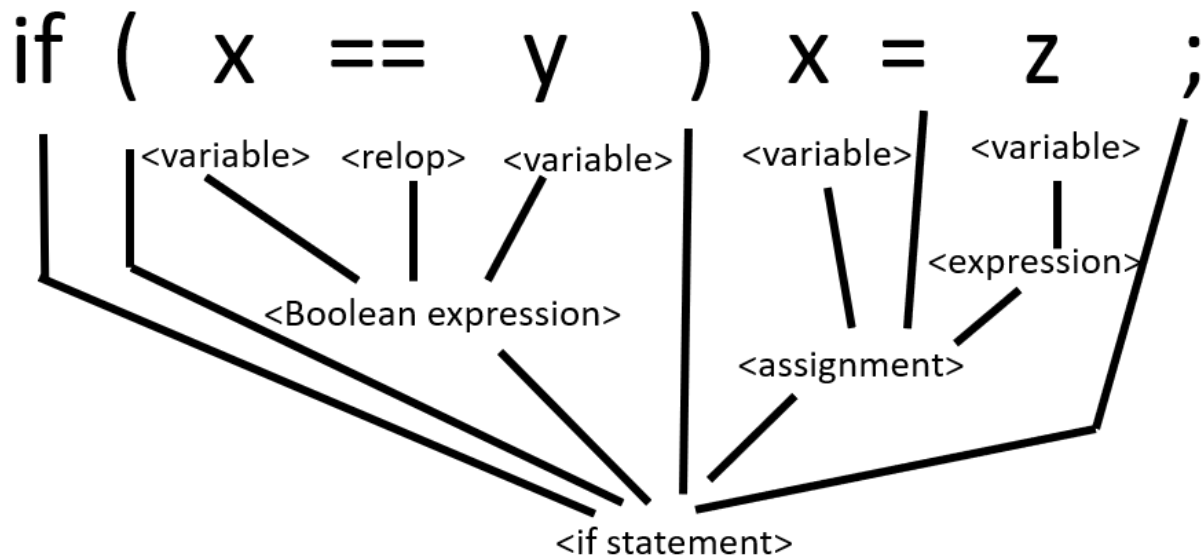
```
<nonzerodigit> ::= 1|2|3|4|5|6|7|8|9
<digit> ::= 0|<nonzerodigit>
<number> ::= +<nonzerodigit><digit>|<nonzerodigit><digit>
```

Which of the following patterns does this grammar match?

- X. 9
- Y. 0
- Z. 01

- A. X only
- B. Y only
- C. Z only
- D. None of X, Y, and Z
- E. All, or two of X, Y, and Z

16. Consider the parsing tree below:



Which of the following BNF grammar definitions could have been involved in the production of this tree?

- X. <relop> ::= ==|<|>
- Y. <if statement> ::= if(<Boolean expression>)<assignment>;
- Z. <if statement> ::= if(<Boolean expression>)<assignment><else clause>;

- A. X and Y only**
- B. X and Z only
- C. Y and Z only
- D. All of X, Y, and Z
- E. None, or only one of X, Y, and Z

17. Which of the following statements are true about semantic analysis during compilation?

- X. A non-terminal symbol may be linked to an existing semantic record.
- Y. A syntactically correct statement is not examined during the semantic analysis phase.
- Z. A syntactically correct statement might be semantically wrong.

- A. X and Y only
- B. X and Z only**
- C. Y and Z only
- D. All of X, Y, and Z
- E. None, or only one of X, Y, and Z

18. Assume that in a multiprocess OS, each process spends about 50% of it's time waiting for I/O operations to be completed. Which of the following statements are true?

- X. If there are 3 processes loaded into memory, the processor utilization will be 75%.
- Y. If there are 2 processes loaded into memory, the processor utilization will be 50%.
- Z. If there are 4 processes loaded into memory, the processor utilization will be 100%.

- A. X only
- B. Y only
- C. Z only
- D. None of X, Y, and Z**
- E. All, or two of X, Y, and Z

19. A file on a Linux machine has permissions `rwxr-xr--`. This file is:

- X. not writable by its owner.
 - Y. not writable by members of its group.
 - Z. writable by other users that are not the owner and not in the file's group.
- A. X only
B. Y only
C. Z only
D. None of X, Y, and Z
E. All, or two of X, Y, and Z

20. A file on a Linux machine should have permissions `rwx--x--x`. Which command do you use to set these permissions?

- A. `chmod 711`
B. `chgrp 771`
C. `chown 711`
D. `chmod 775`
E. `chmod 400`

21. Which of the following statements about file permissions in Unix are correct?

- X. A file can be associated with multiple groups at a time.
 - Y. A file with permissions `drwxrwxrwx` has been deleted.
 - Z. A file with permissions `drw-rw-rw-` is a directory.
- A. X only
B. Y only
C. Z only
D. None of X, Y, and Z
E. All, or two of X, Y, and Z

22. Which of the following situations are deadlocked or might create one?

- X. There are 3 processes each requiring 2 units of a resource R. The system has 4 units of R.
 - Y. Process B is waiting for data from process C. Process C is waiting for A to finish writing to file X that A has locked. Process A is waiting for Process B to release a lock on file Y.
 - Z. Process A is trying to write to a file X that is locked by process B. Process B is waiting for A to finish writing to file Y that A has locked.
- A. X and Y only
 - B. X and Z only
 - C. Y and Z only**
 - D. All of X, Y, and Z
 - E. None, or only one of X, Y, and Z

23. Which of the following features are **essential** in a multi-user operating system?

- X. A superuser (root) account for administration
 - Y. A virtual private network (VPN)
 - Z. Division of processor time into time slices
- A. X and Y only
 - B. X and Z only**
 - C. Y and Z only
 - D. All of X, Y, and Z
 - E. None, or only one of X, Y, and Z

24. Which of the following statements are true about malware?

- X. A virus is carried by an infected host file.
 - Y. The most common mechanism for spreading a virus is through email attachments.
 - Z. A worm is a self-replicating piece of software that does not need a host file to carry it.
- A. X and Y only
 - B. X and Z only
 - C. Y and Z only
 - D. All of X, Y, and Z**
 - E. None, or only one of X, Y, and Z

25. Consider a ciphertext XMAE. If you know that this was encrypted with a Caesar cipher from plaintext LAOS, which of the following could be the key? You may assume that the cipher's alphabet consists of the 26 letters of the English alphabet only.

- A. 12**
- B. 21
- C. 22
- D. 15
- E. 20

26. Consider the plaintext SOURSOP. If encrypted with a Caesar cipher with key 6, which of the following is the ciphertext? You may assume that the cipher's alphabet consists of the 26 letters of the English alphabet only.

A. YUAXYUL
 B. YUAXYUV
 C. YUAKLHI
 D. YUAXMIJ
 E. YUAXYJK

27. Decrypt the ciphertext QCZSZODGS:

A. COLLAPSE
 B. LIFETIME
 C. ACCEPTED
 D. HOMELESS
 E. DATABASE

28. Consider the plaintext FCG over the shortened alphabet A=0, B=1, C=2, D=3, E=4, F=5, G=6, H=7. What is the ciphertext if we encrypted the plaintext with the following block cipher key:

$$\begin{bmatrix} 7 & 5 & 1 \\ 1 & 0 & 2 \\ 4 & 1 & 7 \end{bmatrix}$$

Note: Given the size of the alphabet, you will need to use $\text{mod } 8$.

A. DAC
 B. EEE
 C. CCC
 D. FHD
 E. GAA

29. Which of the following are **TRUE** with respect to RSA?

- X. Messages encrypted with the public key can be used to send confidential information to the owner.
- Y. Messages encrypted with the private key are designed to be able to be decrypted by parties who do not know this key.
- Z. The second part of the public key can be computed once the first part is known.

- A. X and Y only**
- B. X and Z only
- C. Y and Z only
- D. All of X, Y, and Z
- E. None, or only one of X, Y, and Z

30. Which of the following are **TRUE**?

- X. Coaxial cable and twisted-pair cables are types of wireless media.
- Y. A 100 Mbps Ethernet interface takes longer to transmit a 1500 byte frame than a Gigabit Ethernet interface takes for a 9000 byte frame.
- Z. There is no limit to the number of hosts that an Ethernet can support.

- A. X and Y only
- B. X and Z only
- C. Y and Z only
- D. All of X, Y, and Z
- E. None, or only one of X, Y, and Z**

31. Which of the following are **TRUE**?

- X. Antennas for geostationary satellite ground stations do not need to track the satellite by moving the antenna.
- Y. Geostationary satellites offer higher bit rates than medium earth orbit satellites.
- Z. Low earth orbit satellite ground stations need very large tracking antennas at each ground station.

- A. X only**
- B. Y only
- C. Z only
- D. None of X, Y, and Z
- E. All, or two of X, Y, and Z

32. Which of the following are **TRUE** in terms of the maximum achievable bit rate between two hosts connected by this technology?

- X. Fibre has a higher bit rate than ADSL.
- Y. ADSL has a higher bit rate than Fibre for small distances.
- Z. Gigabit Ethernet has a higher bit rate than VDSL.

- A. X and Y only
- B. X and Z only**
- C. Y and Z only
- D. All of X, Y, and Z
- E. None, or only one of X, Y, and Z

33. Which of the following statements are **TRUE** with respect to packet size on a network shared with other hosts?

- X. Larger packet sizes increase the latency on the network cables.
- Y. If we make our packets larger, we increase the risk of losing them to bit errors.
- Z. Small packets cannot be affected by bit errors.

- A. X only
- B. Y only**
- C. Z only
- D. None of X, Y, and Z
- E. All, or two of X, Y, and Z

34. With reference to the OSI layer model, the

- A. network layer interacts with the data link layer above and the presentation layer below.
- B. network layer interacts with the data link layer above and the application layer below.
- C. network layer interacts with the presentation layer above and the application layer below.
- D. network layer interacts with the transport layer above and the data link layer below.**
- E. network layer interacts with the application layer above and the physical layer below.

35. Which of the following are **TRUE** with respect to a TCP-based data communication between two IP hosts on the Internet?
- X. Routers process packets only up to Layer 3 of the OSI model.
 - Y. The Ethernet headers of packets passing through a switch remain unchanged.
 - Z. Routers along the way use the TCP destination port numbers to determine the correct outgoing interface.
- A. X and Y only**
 - B. X and Z only
 - C. Y and Z only
 - D. All of X, Y, and Z
 - E. None, or only one of X, Y, and Z
36. Which of the following are valid sets of instructions for a Turing machine?
- X. (1,0,1,1,L),(1,1,0,3,R),(2,0,1,3,L),(2,1,0,1,L),(2,b,b,2,L)
 - Y. (1,b,0,2,R),(1,1,0,3,R),(2,b,1,1,R),(3,0,0,1,R),(3,0,0,1,L)
 - Z. (1,b,0,2,L),(1,1,0,3,L),(2,0,1,1,R),(3,0,0,1,R),(3,1,0,1,L)
- A. X and Y only
 - B. X and Z only**
 - C. Y and Z only
 - D. All of X, Y, and Z
 - E. None, or only one of X, Y, and Z
37. Consider the following sets of instructions, some of which may not be valid. Which of the sets are valid **and** prevent a Turing machine from halting irrespective of the input to the machine on the tape? You may assume that the machine is in state 1 at the start of execution.
- X. (1,0,0,2,L),(1,1,1,2,R),(1,b,b,1,L),(2,0,1,2,R),(2,b,0,1,L)
 - Y. (1,0,0,2,L),(1,1,0,2,L),(1,b,b,3,R),(2,1,1,1,R),(2,b,0,2,R),(3,0,1,2,L),(3,1,0,1,R),(3,b,b,2,L)
 - Z. (1,0,0,2,L),(1,1,0,2,L),(1,b,b,2,R),(2,0,1,2,L),(2,1,1,1,R),(2,b,0,2,R)
- A. X only
 - B. Y only
 - C. Z only**
 - D. None of X, Y, and Z
 - E. All, or two of X, Y, and Z

38. Consider the following instruction set for a Turing machine:

```
(1, 0, 1, 2, R)
(1, 1, 1, 4, R)
(2, 0, 0, 4, R)
(2, 1, 0, 3, R)
(3, 0, 1, 5, R)
(3, 1, 1, 1, R)
(4, 0, 0, 2, R)
(4, 1, 0, 4, R)
(5, 0, 0, 2, R)
(5, 1, 1, 5, R)
```

If the Turing machine is run on the tape $111100\dots$, starting in state 1 on the first symbol on left of the tape, which state does it end up in after executing 6 instructions?

- A. State 1
- B. State 4**
- C. State 3
- D. State 5
- E. State 2

39. Consider the following instruction set for a Turing machine:

```
(1, 0, 1, 2, R)
(1, 1, 0, 4, R)
(2, 0, 0, 5, R)
(2, 1, 0, 3, R)
(3, 0, 0, 5, R)
(3, 1, 1, 1, R)
(4, 0, 1, 2, R)
(4, 1, 1, 4, R)
(5, 0, 1, 2, R)
(5, 1, 0, 4, R)
```

If the Turing machine is run on the tape $111010\dots$, starting in state 1 on the first symbol on the left of the tape, what is written on the tape after 6 instructions have been executed?

- A. ...011100...**
- B. ...011000...
- C. ...001100...
- D. ...010100...
- E. ...111100...

40. Which of the following statements on Turing machines are **TRUE**?

- X. Each state in a Turing machine corresponds to one instruction.
- Y. A Turing machine changes to a different state at each clock tick.
- Z. The number of instructions for a Turing machine is finite.

- A. X and Y only
- B. X and Z only
- C. Y and Z only
- D. All of X, Y, and Z
- E. None, or only one of X, Y, and Z

41. Which of the following are reasoning tasks?

- X. Solving a sudoku puzzle.
- Y. Deciding whether it is safe for a drone to fly in a zone.
- Z. Deciding what to wear based on weather conditions.

- A. X and Y only
- B. X and Z only
- C. Y and Z only
- D. All of X, Y, and Z
- E. None, or only one of X, Y, and Z

42. Which of the following statements about back propagation in neural networks is **TRUE**?

- X. Error information is passed back from the output neurons to reduce the number of inputs.
- Y. If an output neuron failed to fire, its negative (inhibitory) weights are decreased.
- Z. If an output neuron fired erroneously, its negative (inhibitory) weights are increased.

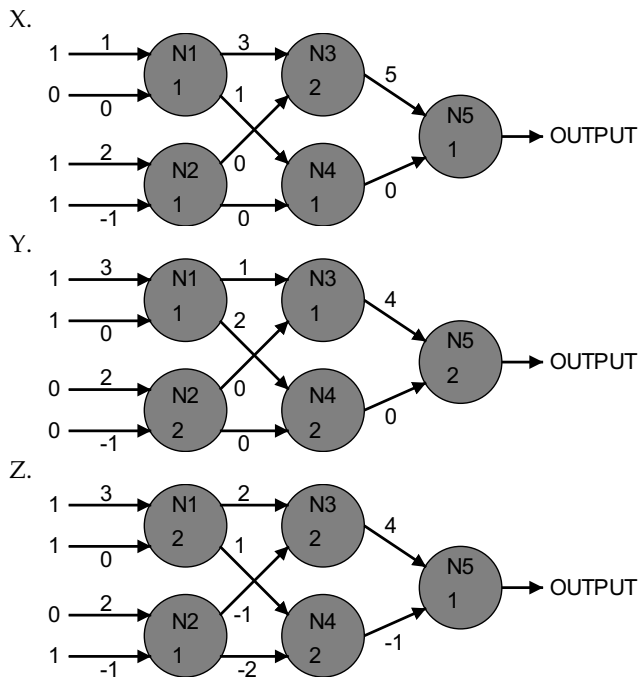
- A. X and Y only
- B. X and Z only
- C. Y and Z only
- D. All of X, Y, and Z
- E. None, or only one of X, Y, and Z

43. Which of the following statements on robots are **TRUE**?

- X. The difference between robots and plain machines is that robots always carry out reasoning tasks.
- Y. Robots always learn when they carry out their tasks.
- Z. Robots are used for tasks that they can carry out more reliably than humans.

- A. X only
- B. Y only
- C. Z only**
- D. None of X, Y, and Z
- E. All, or two of X, Y, and Z

44. Consider the following neural networks. Which networks output 1?



- A. X and Y only
- B. X and Z only
- C. Y and Z only
- D. All of X, Y, and Z**
- E. None, or only one of X, Y, and Z

45. Which of the following sentences could be used as a Winograd schema?

- X. Mary tucked her daughter Anne into bed so that she could sleep.
- Y. Alice and Bob went for a drink after they had finished work.
- Z. The night fell before they had arrived at their destination.

A. X only

B. Y only

C. Z only

D. None of X, Y, and Z

E. All, or two of X, Y, and Z

Appendix

FIGURE 6.5

| Binary Op Code | Operation | Meaning |
|----------------|-------------|--|
| 0000 | LOAD X | $CON(X) \rightarrow R$ |
| 0001 | STORE X | $R \rightarrow CON(X)$ |
| 0010 | CLEAR X | $0 \rightarrow CON(X)$ |
| 0011 | ADD X | $R + CON(X) \rightarrow R$ |
| 0100 | INCREMENT X | $CON(X) + 1 \rightarrow CON(X)$ |
| 0101 | SUBTRACT X | $R - CON(X) \rightarrow R$ |
| 0110 | DECREMENT X | $CON(X) - 1 \rightarrow CON(X)$ |
| 0111 | COMPARE X | if $CON(X) > R$ then $GT = 1$ else 0 if $CON(X) = R$ then $EQ = 1$ else 0 if $CON(X) < R$ then $LT = 1$ else 0 |
| 1000 | JUMP X | Get the next instruction from memory location X. |
| 1001 | JUMPGT X | Get the next instruction from memory location X if $GT = 1$. |
| 1010 | JUMPEQ X | Get the next instruction from memory location X if $EQ = 1$. |
| 1011 | JUMPLT X | Get the next instruction from memory location X if $LT = 1$. |
| 1100 | JUMPNEQ X | Get the next instruction from memory location X if $EQ = 0$. |
| 1101 | IN X | Input an integer value from the standard input device and store into memory cell X. |
| 1110 | OUT X | Output, in decimal notation, the value stored in memory cell X. |
| 1111 | HALT | Stop program execution. |

Typical assembly language instruction set

